FRED Reports

RAINBOW TROUT (*Salmo gairdneri*)
BROODSTOCK MANAGEMENT TECHNIQUES
USED IN THE UNITED STATES AND CANADA

By
Marianne McKean and Irvin R Brock

Number 84

Alaska Department of Fish & Game
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ABSTRACT

In February of 1987, questionnaires concerning rainbow trout (*Salmo gairdneri*) broodstock rearing techniques were sent out to 359 private, state and federal rainbow trout hatcheries in the United States and Canada. The questionnaire was made up of 55 questions pertaining to issues in broodstock management including feed type, feeding frequency, spawning procedures and incubation procedures. Fifty questionnaires were returned. In general most of the respondents: reared broodstock in raceways using well or spring water and fed a dry broodstock diet. Broodstock were spawned during all months of the year; most respondents hand-stripped females into hard containers and directly added sperm. Eggs were usually incubated in Heath-type incubators.

KEYWORDS: Rainbow trout, *Salmo gairdneri*, broodstock, feeding, rearing, eggtake, United States, Canada, fish culture

INTRODUCTION

The Broodstock Development Center at Fort Richardson, Alaska, started operating in 1986, and is the only rainbow trout (*Salmo gairdneri*) broodstock facility in Alaska. At present, eggs from broodstock raised at the center annually produce 2.5 million fingerling rainbow trout and 200,000 catchable-sized rainbow trout. In addition to these production requirements, there is a genetic selection program for the broodstock at the center. Because of the geographic separation between the Broodstock Development Center and other rainbow trout broodstock facilities in the United States and Canada, it has been difficult to obtain and share information about current hatchery techniques. The purpose of this study was to find out how other broodstock facilities operate, and to share this information. Questionnaires sent to hatcheries in the United States and Canada consisted of multiple choice, fill-in-the-blank, or brief essay answers requesting information about different procedures used for genetic selection, rearing, spawning, and incubation of rainbow trout.

MATERIALS AND METHODS

A questionnaire was designed consisting of 55 questions addressing issues in hatchery broodstock management. Yes/no and multiple choice type questions were asked as often as possible to simplify answering and data analysis.

We attempted to contact as many rainbow trout broodstock facilities in the United States and Canada as possible; but some were missed. Addresses for public and private facilities were found in the National Listing of Fishery Resource Program Offices (Anon, 1986). Addresses for state facilities were found by contacting the appropriate state agencies in each state and requesting addresses of public and private rainbow trout broodstock facilities operating in that state. Addresses of some private facilities were from the index of Aquaculture Magazine Buyers Guide (Anon, 1987) and from addresses provided by questionnaire respondents. Because we had no comprehensive information about these facilities, many questionnaires were sent to facilities where rainbow trout broodstock may not have been reared.

A total of 359 questionnaire packets were mailed in February, 1987. Each packet contained a blank questionnaire and a sample completed questionnaire. Completed questionnaires were received from 50 rainbow trout broodstock facilities by 15 April 1987 (Appendix A). The data was coded and summarized; means and percents were calculated.

DISCUSSION

General

The specific brands of fish food and fish culture equipment have been retained in this report, but they are not endorsed by the State of Alaska. Percentages may often sum to more than 100 percent as some hatcheries used more than one of the listed techniques.

Thirty-four responses were from state or provincial agencies, 6 from federal agencies, and 10 from private hatcheries. Generally all of the questions that applied to the responding facility were answered thoroughly.

Fifty-five strains of rainbow trout were used by reporting hatcheries. The most common strain was Arlee (Appendix A). The smallest responding facility held 176 broodfish over one year old while the largest held 27,000 broodfish.

Holding and rearing procedures

Most respondents used ponds (89%) or raceways (84%) for holding and rearing their broodstock; others used tanks (7%) or troughs (2%) or some combination there of. The average rearing density was 30.44 kg/m^3, (range: 4 to 80 kg/m^3). Closed water sources, wells (33%) and springs (69%), were the most common sources of water. Only 16% of the facilities had an open water source such as a stream or lake. Few of the respondents (15%) manipulated their water temperatures. When temperatures were manipulated, it was either to alter the rate of sexual maturation, or to conduct experiments. Most facilities used water at a constant temperature that averaged 11.1° C year-round, (range: 6.5 to 14.5° C) (Figure 1). Several facilities (16%) also manipulated photoperiods.

Fish food was categorized by general type: dry, semi-dry or moist. Each of these types could be used for either broodstock or production fish. We considered semi-dry diets were considered the same as semi-moist diets. A complete listing of feeds reported can be found in Table 1. The type of food most commonly fed was a dry broodstock diet (Figure 2) with the brand name of "Silver Cup". Broodstock were generally fed manually (70%) twice daily, though many of the respondents used automatic (12%), demand (27%), or truck-mounted blower (4%) feeders either alone or in conjunction with manual feeding. Forty-eight percent of the facilities changed their feeding regime after the fish were spawned. Changes include decreasing (52%) or increasing (26%) the amount of food, changing the type of food (14%), or not feeding because the fish are released (9%). These changes followed no consistent pattern.

Fish for replacement broodstock were generally selected according to specific characteristics. Some respondents reported that fish were replaced through a random selection procedure, but as we reviewed their procedures it appeared that a nonrandom process was used. Traits selected included one or more of the following:

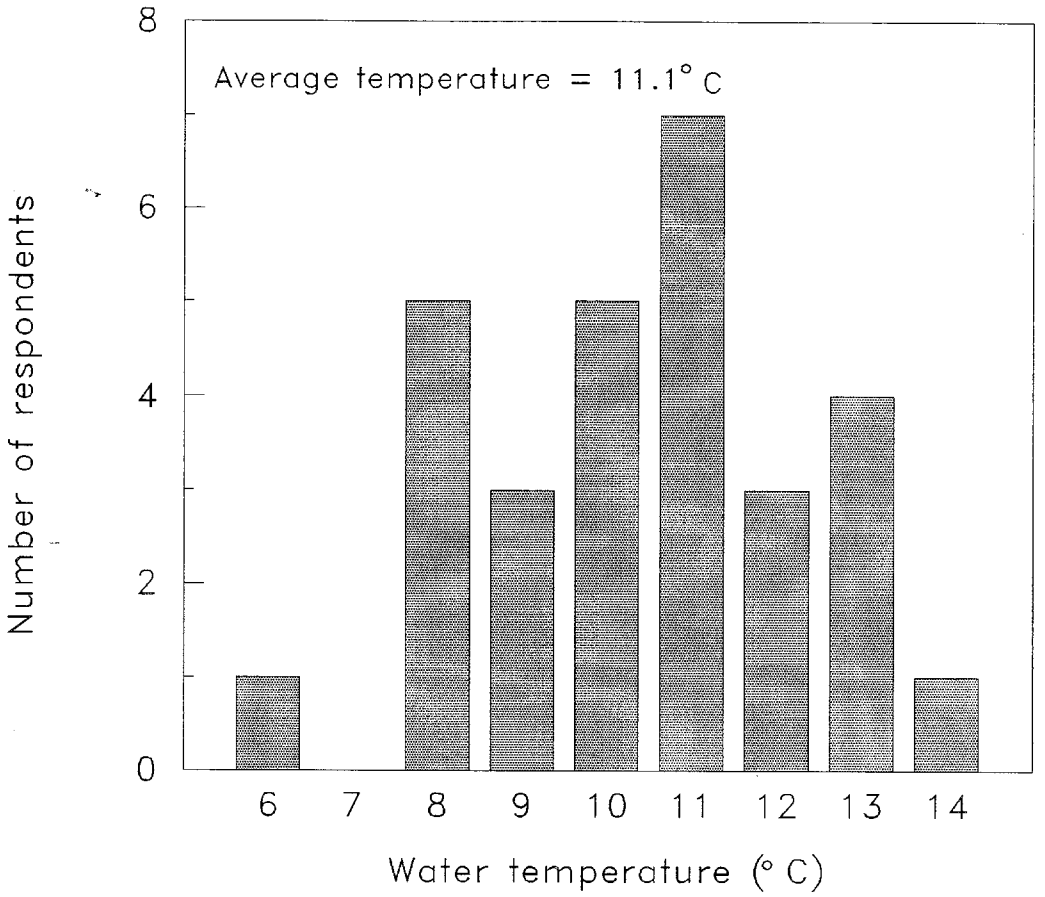

Figure 1. Average water temperatures reported by hatcheries with a constant temperature water supply.

Table 1. Fish food fed to rainbow trout broodstock.

Brand/Manufacturer	Responses	
	Number	%[a/]
Silver Cup	20	40.8
Rangens	14	28.6
Bioproducts	6	12.2
Moore Clark	5	10.2
FWS	4	8.2
Glencoe	3	6.1
Balshi	3	6.1
Martin Feed Mill	3	6.1
Clear Spring Trout	3	6.1
NY State	1	2.0
WI State	1	2.0
OMP	1	2.0

[a/] Percentages sum to more than 100 because some respondents use more than one product.

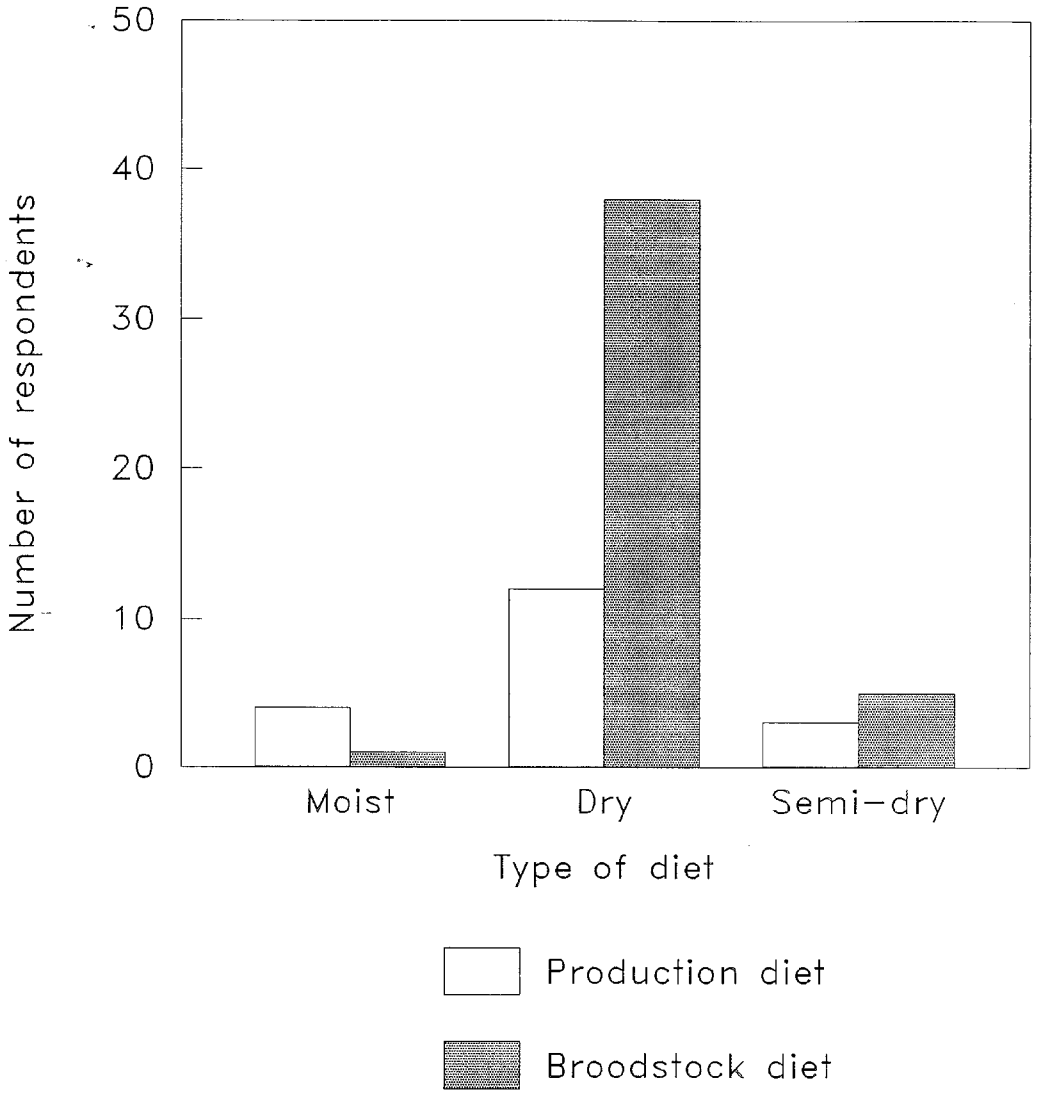

Figure 2. Types of diets fed by respondents.

growth rate, fecundity, survival, body conformation, spawn timing, disease resistance, and size.

The average survival rates between lifestages are presented in Table 2. Some respondents reported high (up to 75%) mortality of either two-year-old males (19% of the facilities) or high mortalities of all broodstock (22% of the facilities).

Spawning procedures

Rainbow trout broodstock were spawned during all months of the year, but most were spawned between September and February (Figure 3). Two-year-old males and three-year-old females were used most frequently for spawning (Figure 4). Average fecundity increased through age five, but decreased in the sixth year; however, only three broodstocks included six-year-old fish (Figure 5). The average weight of a female fish was slightly greater than the average weight of a male at the same age, especially among six-year-old fish (Figure 6).

Ripeness of the female broodstock was usually checked weekly. Sorting for ripeness was usually done after crowding fish into the spawning area where most of the facilities (76%) used an anesthetic prior to sorting. The types of anesthetics used are listed in Table 3. Several facilities allowed fish to migrate to the spawning area. The largest daily eggtake involved the spawning of 1,200 females, the smallest included a single female. Most respondents (82%) hand-stripped the females. Others used air or oxygen to force the eggs out of the female. Of the respondents, 82% reported separating the ovarian fluid from the eggs as they were taken (dry spawning); the ovarian fluid was left with the eggs (wet spawning) at 20% of the facilities. Eggs at most facilities (74%) were collected in a hard container, such as a pan or colander. At other facilities, eggs were collected in a soft container like a net. Most respondents (84%) examined eggs for gross abnormalities to determine if they should be discarded. Eggs from more than one female were usually pooled in a container before they were fertilized. Eggs from an average of six females were pooled (range: 2 to 26).

Sperm was generally added directly to the eggs, although at some of the facilities (43%), the sperm from several males was pooled (29%) or pre-collected (16%) prior to fertilization. Male:female fertilization ratios generally varied from 1:1 to 1:6. Water was added immediately after fertilization. Eleven respondents reported using saline rather than fresh water for the eggs. Eggs were usually disinfected with an iodophor (Table 4). Some respondents (34%) checked the fertility rate of the eggs. Techniques used to check fertility included clearing eggs with acetic acid (Leitritz and Lewis, 1976), correlating fertility with sperm motility, or assuming all dead eyed-eggs were infertile.

Table 2. Survival rate of rainbow trout broodstock between lifestages.

Lifestage		Survival (%)		
From	To	Average[a/]	Maximum	Minimum
green	eyed egg	76	98	27
eyed egg	emergence	88	99	50
emergence	2 g	90	99	52
2 g	1 year	89	99	73
1 year	2 years	92	99	70
2 years	3 years	90	99	60
3 years	4 years	86	99	40
> 4 years		76	99	25

[a/] Weighted average based on the number of all fish at each facility

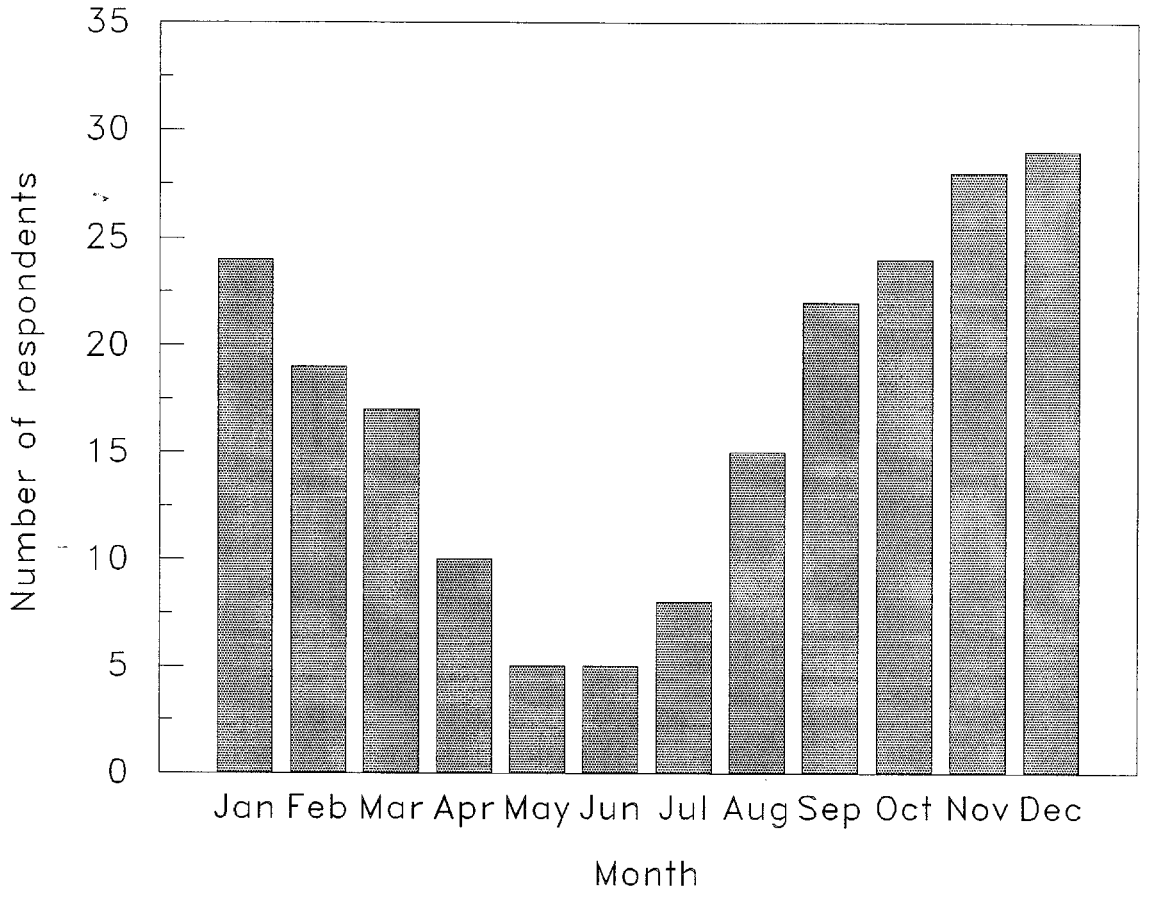

Figure 3. Number of hatcheries that spawned rainbow trout broodstock each month of the year. Some hatcheries spawned during more than one month.

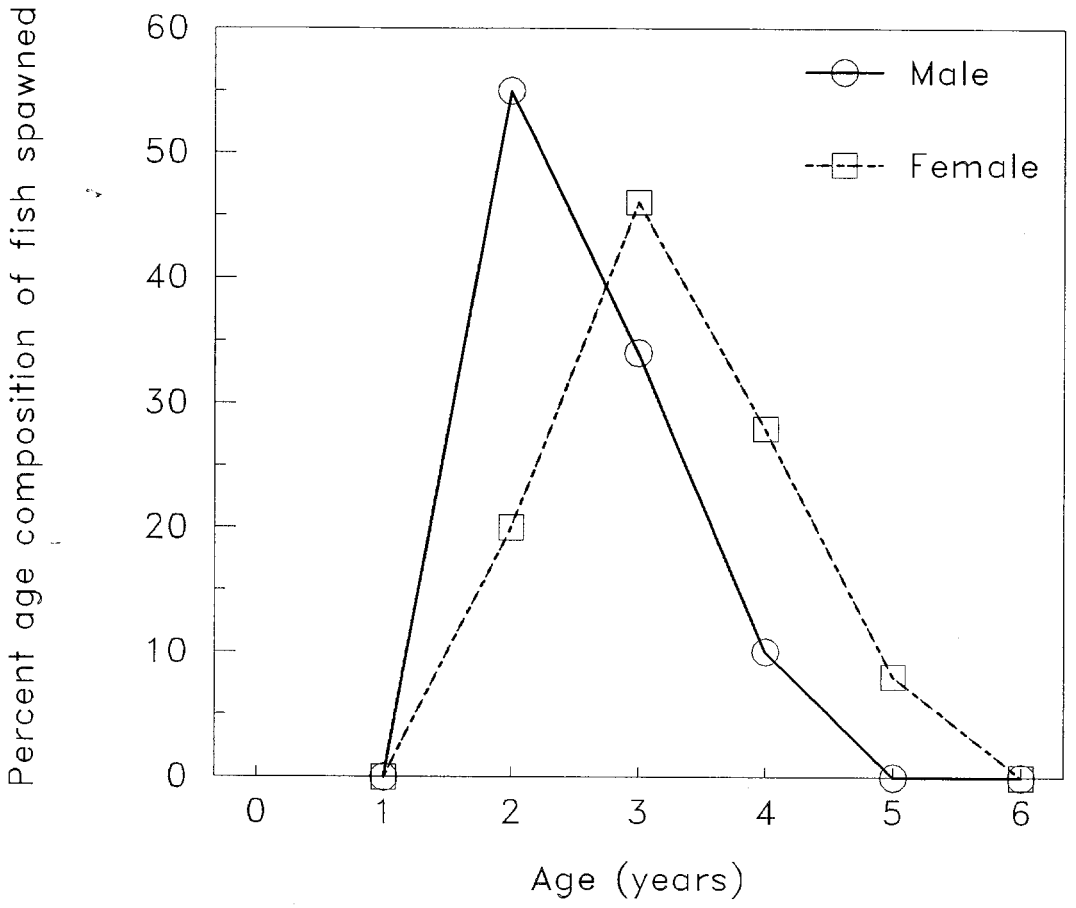

Figure 4. Percent age class distributions of male and female rainbow trout broodstock populations

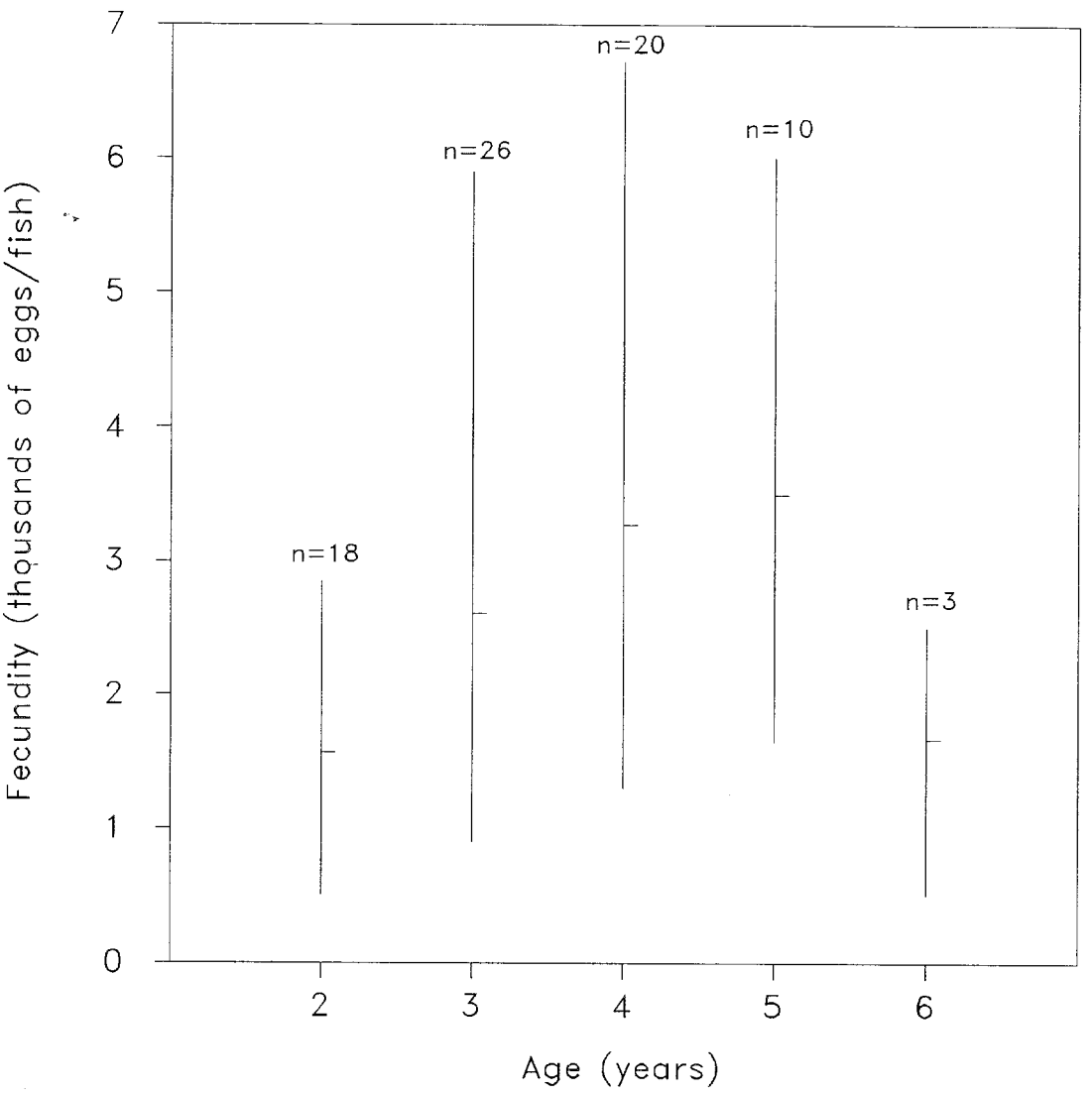

Figure 5. Average fecundity (eggs/fish) of each age class. N = number of strains. (Horizontal bar indicates average; vertical bar indicates range.)

Figure 6. Average broodstock weights by age class

Table 3. Anesthetics used prior to sorting rainbow trout broodstock for sexual ripeness.

Anesthetic	Responses	
	number	%[a/]
MS222	28	73.7
Quinaldyne	8	21.1
Phenooxyethanol	4	10.5
Chloratone	1	2.6
Methyl Pentynol	1	2.6

[a/] Percentages sum to more than 100 because some respondents use more than one product.

Table 4. Disinfectants used for rainbow trout eggs.

Disinfectant	Responses	
	number	%[a/]
Betadine	13	43.3
Wescodine	10	33.3
Argentyne	9	30.0
Pharmadine	1	3.3
Erythromycin	1	3.3
Gallimycin	1	3.3

[a/] Percentages sum to more than 100 because some respondents use more than one product.

Incubation procedures

Most respondents (82%) allowed the eggs to water harden, or absorb water, before the eggs were placed in incubators. General incubator types included drip, downwelling, and upwelling incubators, eyeing troughs and eyeing jars. The most common type of incubator used (53%) was a "Heath" upwelling incubator (Table 5). Substrates such as astroturf were used at some facilities (10%) during incubation. Both green and eyed eggs were most often enumerated using a volumetric technique such as Burrows Displacement technique (Lietritz and Lewis, 1976). The average incubation temperatures used for green to eyed-egg stages and eyed-egg to emergence stages are both 11.1° C (Range: 6.5° C to 15° C). A few facilities (24%) allowed the fry to swim out of the incubators into troughs or raceways on their volition, but at most facilities fry were removed after the yolk sac had absorbed and manually placed in rearing containers.

Miscellaneous

Two questions were asked to answer specific problems at the Broodstock Development Center. First, respondents were asked if they had noted "extremely tender eggs" during eggtake, and if they could explain it. Most respondents suggested that this condition resulted when eggs are taken from overripe females. Others suggested that it resulted from improper adult handling, dietary deficiencies, or poor water quality. Second, at the Broodstock Development Center, some eggs have exceptionally small eyes; these embryos invariably die after hatching. We asked if others had observed this condition. Many of the respondents report having seen this problem, although usually not severe enough for alarm. Some suggested causes include poor water quality, excessive handling, genetic defects, and broodstock dietary deficiencies.

Conclusion

This report is intended to provide an overview of techniques used at rainbow trout broodstock facilities in North America. It is not intended as a guide to correct procedures, but instead to document current broodstock management procedures and for us to see how techniques used at the Broodstock Development Center compared with methods used elsewhere. We did find that techniques used at the Broodstock Development Center are much the same as those used in the "lower forty-eight". With this report, we also hope to promote an interchange of ideas and communications among broodstock facilities in North America.

Table 5. Incubators used for rainbow trout eggs.

Incubator	Responses	
	number	%[a/]
Heath tray	26	53.1
Hatching baskets	7	14.3
Upwelling jars	6	12.2
Eyeing jars	4	8.2
Drip incubator	2	4.1
Robertson incubator	1	2.0
Nolan incubator	1	2.0
Clark-Williamson incubator	1	2.0
Downwelling buckets	1	2.0
Montana hatching box	1	2.0

[a/] Percentages sum to more than 100 because some respondents use more than one incubator.

ACKNOWLEDGMENTS

We would like to thank all of the respondents who took the time to fill out this questionnaire. We would also like to thank Carmen Olito, Bill Hauser, and John Burke for help and editing.

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APPENDIX A

Appendix A. Questionnaire respondents and rainbow trout broodstock strains used.

Hatchery name	Broodstock strain	State/ province	Agency[a/]
Aquafarms Canada, Ltd	Not specified	Ontario	P
Aqua-Cage Fisheries, Ltd	Not specified	Ontario	P
Bellefonte Fish Culture Stat.	Bellefonte	Penn	S
Big Spring Hatchery	Big Spring/ Tomalonis	Penn	S
Blue Spring Trout Farm	Blue Spring Trout Farm	Ontario	P
Boulder Fish Rearing Station	Kemmeces City Reservoir	Wyoming	S
Bozeman Fish Tech Center	Arlee	Montana	F
	Eagle Lake		
	Erwin		
	Kamloop		
Broodstock Development Cent.	Big Lake	Alaska	S
	Swanson		
	Swanson Select		
Buford Trout Hatchery	Winthrop	Georgia	S
Cleghorn Springs Hatchery	Growth	S Dakota	S
	Kamloop		
Cline Trout Farm	Not specified	Nebraska	P
	Kamloop		
Creston NFH	Eagle Lake	Montana	F
Crystal Lake Fisheries	Emerson	Montana	P
Dr Harry M Gallagher	Mt Shasta	Nevada	S
	Sand Creek		
	Tasmanian		
Durango Hatchery	6F2	Colorado	S
	Arlee		
	Erwin		
Egan Hatchery	Albino	Utah	S
	Fish Lake/DeSmet		
	Sand Creek		
	Shepard of the Hills		
	Ten Sleep		
Ennis National Fish Hatchery	Arlee	Montana	F
	Erwin		

-Continued-

[a/] Agencies: P = private, S = state or provincial, F = federal

Appendix A. Questionnaire respondents and rainbow trout broodstock strains used (continued).

Hatchery name	Broodstock strain	State/ province	Agency[a/]
Ennis National Fish Hatchery	Kamloop McConaughy Redband Shasta	Montana	F
Erwin National Fish Hatchery	Ennis Fish Lake McConaughy Wytheville	Tennessee	F
Fish Research Hatchery	6F2 Arlee	Colorado	S
Fraser Valley Trout Hatchery	Fraser Valley	B Columbia	S
Goldendale Trout Hatchery	McCloud	Washington	S
Hayspur Hatchery	Hayspur	Idaho	S
Hot Creek SFH	Coleman Hot Creek	California	S
Jake Wolf Hatchery	Skamania	Illinois	S
Jocko River Trout Hatchery	Arlee Arlee Early	Montana	S
Kootenay Trout Hatchery	Gerrard	B Columbia	S
London Fish Hatchery	Golden -London London	Ohio	S
Manchester Trout Hatchery	Not specified	Iowa	S
Normandale Fish Culture Stat.	Bothwell Ganaraska Nottawasaga	Ontario	S
Osceola Fish Hatchery	Erwin Shasta	Wisconsin	S
Paint Bank Trout Hatchery	Ennis Wytheville	Virginia	S
Pequest SFH	White Sulpher Springs	N Jersey	S
Petersburg Trout Hatchery	Golden- W Sulpher Springs White Sulpher Springs	W Virginia	S
Quinebaug Valley Trout Hatch.	Beulah	Connecticut	S

-Continued-

[a/] Agencies: P = private, S = state or provincial, F = federal

Appendix A. Questionnaire respondents and rainbow trout broodstock strains used (continued).

Hatchery name	Broodstock strain	State/ province	Agency[a/]
Quinebaug Valley Trout Hatch.	Kamloop	Connecticut	S
	Nashua		
	White Sulpher Springs		
Rainbow Springs Hatchery	Stevenson	Ontario	P
Reeds Creek Hatchery	Shasta	W Virginia	S
	West Virginia		
Roaring River Fish Hatchery	Cape Cod	Oregon	S
Rock Creek Hatchery	McConaughy	Nebraska	S
Rockwood Fish Hatchery	Manx	Manitoba	F
	Mt Lassen		
	Nisqually		
	Penask		
	Sundalsora		
	Tagwerker		
	Tunkwa		
Seth Green Hatchery	Leetown, accl. grwth	New York	S
	Nashua		
	Western Fisheries Center		
	Winthrop		
Shepard of the Hills	Donaldson	Montana	S
	Shepard of the Hills		
Soda Springs Brood Station	Missouri	Idaho	P
South Tacoma Hatchery	South Tacoma	Washington	S
Spokane Hatchery	Cape Cod	Washington	S
Ten Sleep - Wigwam	Wigwam fall-spawn	Wyoming	S
Tillett Springs Rearing Stat.	Eagle Lake	Wyoming	S
Trophy Fish Ranch	Sevier Valley	Utah	P
Troutdale Ranch	Hot Creek	Montana	P
White Sulpher Springs	Wytheville	W Virginia	F
Wildsprings, Inc	Cook Creek	Minnesota	P
	Pine		

[a/] Agencies: P = private, S = state or provincial, F = federal